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Applied Statistics in the Classroom

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Applied Statistics in the Classroom

by

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Dedication

I dedicate this work to my loving, supportive parents, without whom I could not have the resolve and perseverance to extend my education this far. My parents inspire me to reach for seemingly unattainable heights and to continue striving through both hard times and good, for they have shown me what can be accomplished through honest, hard work. I owe any degree of success I achieve to them.

I also want to thank my educators and mentors for their help and guidance throughout this program. They have set forth such a model of excellence and professionalism that is truly motivational. I will consider myself blessed to attain but a fraction of the poise and regard they have.

Applied Statistics in the Classroom

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The purpose of this report is to give teachers of AP Statistics a way to enrich student learning with an engaging, rigorous and relevant project. The report details the reasons necessary for student-based learning, along with examples in which projects in classrooms were successful. The project is centered on categorical data analysis involving tests of proportions, chi-squared distributions and confidence intervals. There are supplemental worksheets provided with the intent of showing students the relevance and applications of what they are learning to actual studies. Finally, a rubric is provided for students to align and focus their projects as well as for teachers to assess student learning.

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Chapter 1: Introduction

Statistical knowledge and understanding play an important part in connecting mathematics to our everyday lives and take a central role in exercising citizenship. We are constantly called upon to make choices based on analyzing data and frequent references to statistics fill our days. (Carvalho and Solomon 2012) From politics to science, healthcare to sports, shopping, money management or even checking the weather, collecting, organizing, describing and interpreting data are skills that are increasingly important and are the core of statistics. Therefore, improving these skills should be the main goal of statistics education.

Statistics is important for various disciplines such as education, business, psychology and government. Our world is rapidly changing and students, as future members of the workforce, will need to reason mathematically to use advanced technology and other sophisticated resources to stay current with this evolving technology. As such, students require access to quality mathematics education or we risk hindering their success. (Halili and Olea 2012) Statistics education teaches how to read and comprehend data and studies presented in scientific publications, newspapers and other media, evaluate arguments based on research and then make sound decisions informed by data. These are necessary skills for reading and understanding information encountered in daily life, advancing further in one's career and continuing one's education. (Cantürk-Günhan , Bukova-Güzel & Özgür 2012)

Applied statistics in the classroom is immensely helpful to our students. As teachers, we have to keep our students interested long enough so that learning can take place. In this regard, statistics has the ability to delve into their lives, building mathematics around them in ways that are directly relatable to our students and engage them in ways that surpass traditional teaching methods. Students are more willing to participate in assignments that directly relate to their everyday lives. Studying local issues, the issues of their peers and subjects relevant to the student can increase motivation and strengthen understanding. An applied statistics class or a course integrating applied statistics can accomplish these goals for us as teachers and our students. (Burdette and McLoughlin 2010)

To this end, incorporating applied statistics into the classroom is necessary not just for statistics education but education as a whole. The inferential reasoning that comes from statistics is essential in our school curriculum. The obvious choice is in an AP Statistics classroom where all subjects can be broached. Any topic in the news can be made into an AP Statistics lesson of the day and, if done correctly, an engaging, relatable and worthwhile unit. By making students grapple with intriguing real-world problems that demonstrate the intellectual content and broad applicability of statistics as a discipline, we can foster critical reasoning skills and inferential reasoning necessary to elevate our students to the next level and ready them for post-secondary education and the workforce.

Chapter 2: Review of Literature

Statistics in the Classroom: A Brief History

Statistics, as a discipline, has been around for roughly 250 years, making it a relatively new mathematical concept. As a high school course, statistics is still in its infancy. The first AP Statistics course was not taught until the 1996-1997 school year. Before this, statistics classes were not very cohesive. The first curriculum strand by the National Council of Teachers of Mathematics was not published until the late 1980s. The strand contained data analysis and probability which, before, had no identifiable place in the K-12 curriculum. However, teachers failed to promote data analysis in their classrooms in the mid-90s, spending less time than what was proposed, despite interventions and adequate resources provided. (Franklin, Hartlaub, Peck, Scheaffer, Thiel and Freier 2011)

This coincided with The College Board's interest in offering a statistics course. The amount of mathematical science courses offered by The College Board was slim and the institution was looking to expand this section. The developers of this course focused on conceptual understanding and understood the importance of technological advances in mathematics as a tool for data collection, analysis and conceptual understanding. (Franklin, Hartlaub, Peck, Scheaffer, Thiel and Freier 2011)

As an AP course, The College Board needed AP Statistics to be accepted by colleges and universities as credit for an introductory statistics course. To do so, the developers decided that AP Statistics would cover more content topics than what typical college-level introductory statistics classes cover. Despite not mirroring a typical college course in its first years, universities, colleges, professors and other mathematical entities decided that The College Board had developed a richer, deeper, more engaging and more effective curriculum. Introductory statistics courses at colleges have now been transformed based on the achievements, research and success of AP Statistics. (Franklin, Hartlaub, Peck, Scheaffer, Thiel and Freier 2011)

The Importance of Applied Statistics in the Classroom

Teachers today have the responsibility of narrowing down the different aspects of various subjects and applying them to their lessons. If done correctly, these lectures further the ability of students to "question reality, identify the knowledge required for dealing with problems common in daily life and assess the appropriateness of knowledge and procedures". (Carvalho and Solomon 2012) One problem that commonly arises in this area is that different social classes and ethnicities have differing perspectives in their daily lives and the problems they encounter. For instance, word problems combine mathematics with familiar situations that normally are not associated with mathematics. Because the circumstances of the problems are familiar enough, students incorporate their own understanding of everyday life into the problem. The dilemma for the educator then becomes discerning what the student's understanding of everyday life is and its appropriateness for the current problem. Working class students, more so than middle class students, are more likely to accidentally call upon "inappropriate" every day knowledge because "the sense of the 'obvious' or the 'appropriate' has to be learned, either in the home or the school" (Carvalho and Solomon 2012). Working class students are at a disadvantage in this respect, having to rely primarily upon school to teach them this sense of the 'obvious'.

In the statistics classroom, we can help overcome these issues by relating statistics to real life, organizing open-ended activities and infusing these activities with guided questions. (Cantürk-Günhan , Bukova-Güzel & Özgür 2012) The transition from traditional lectures to open-ended activities can be done through the use of these guided questions, which can lead students through an entire research process and keep teacher-centered instruction to a minimum. This method of learning helps move students from doing short, focused homework problems to creating open-ended investigations using statistics that can last upwards to an entire term (Kuiper and Collins 2009). Students then become more engaged and more willing to examine "nuances and difficulties that seem unimportant in a traditional textbook/lecture presentation" (Root and Thorme 2001).

Student-centered learning, in which the student plays an active role in their own education, gives students opportunities to apply prior knowledge to new situations and achieve new knowledge through this interaction. If students are only exposed to the traditional way of learning, they cannot learn how to analyze information critically or deal with original problems or situations (Cantürk-Günhan , Bukova-Güzel & Özgür 2012). To accomplish this goal, statistics should be problem-solving rather than simply formulas and rote operations. Students should have the opportunity to become statisticians through data analysis of real sets of data that provide legitimacy and credibility to the project. Analysis of data and critical thinking through higher-ordered questioning of the world presented to our students is much needed in disciplines involving statistics. Combining this with critical discussion at each crucial juncture of the project of how and why statistics are used provide enriching, worthwhile and relatable learning opportunities in ways that traditional lecturing simply cannot (Carvalho and Solomon 2012).

The Current State of Applied Statistics in the Classroom

Applied statistics in the classroom is still a relatively new field but is emerging quickly. The University of Toronto offers a series of First Year Seminars, titled 'Lies, Damned Lies, and Statistics' intended to serve as a small-group learning experience for the students. The seminar has no assigned textbook, instead choosing current news items, health studies and clinical trials to discuss descriptive statistics, linear regression, confounding variables, time series, ethics in statistical practice and other topics that normally do not appear in an introductory statistics class. The seminar generally receives positive reviews and provides a great refresher course for beginning statistics students who plan to take an introductory statistics course (Plante and Reid 2011).

An applied statistics project done at a community college had students in introductory sociology courses compare and contrast the demographic characteristics of two counties in their state using the data from the 2000 Census Bureau. Students compared and contrasted the two counties' local media information and sociological thinking. The project had five main steps: data collection, critical examination of the data, formulation of two research questions, literature research, and a summary. Throughout the project, students made connections and used a sociological framework to understand trends in their local communities. (Burdette and McLoughlin 2010)

Another college had a course that was a series of 2-3 weeklong guided labs of increasing difficulty. The first lab had students figure out how to predict the worth of a car through multiple linear regression of various pre-determined data sets and heavily guided leading questions. The next set of labs set aside a day for discussion over assigned reading related to the lab, followed by data analysis, interpretation and presentations of their findings. Later, in more advanced labs, students formulated their own hypotheses and explanatory variables. The professors have found that this course and the labs involved improve the overall quality of student work. Students are better able to develop research questions that are general enough to be interesting, yet specific enough to analyze in the given time frame. Students become enthusiastic about their work and improve upon the presentation of key concepts to peers and faculty. (Kuiper and Collins 2009)

A professor at a different college implements statistics projects in her social work statistics class. She first identifies a community social service agency wanting data analysis assistance and then structures class assignments around that agency's data and her prescribed textbook. Students spend a few weeks of the course working on preparing agency documents for data entry and entering the data, which, with teacher-led discussions and guiding questions, coincides with coverage of introductory chapters in the course text. The first major class assignment evaluates student interpretations of frequency tables, measures of central tendency, figures and graphs, and other descriptive statistics. Class sessions in the second half of the semester are divided into class lecture and hands-on bivariate data analysis, focusing on chi square, t test, ANOVA, and correlation to stay aligned with the textbook. The second major class assignment evaluates student interpretation of appropriate bivariate or multivariate analyses, or both. Students revise the first two major assignments and put together a final report for the community agency. (Wells 2006)

Problems with Applied Statistics in the Classroom

In the previous examples, some common problems occurred. Students reported that they did not have enough time to properly analyze the data and do more with their project. Students also complained that data entry is too time consuming and difficult (Wells 2006).Conducting literature research also proved problematic. Finding useful, reliable sources was the most difficult part for most projects. Students turned in papers trying to explain their research questions without using any sources or using unreliable sources, such as blogs or non-credible Web sites (Burdette and McLoughlin 2010).

Another, somewhat surprising, problem is over-skepticism in dealing with articles. Many newspaper articles are overstated and tend to use misleading statistics to increase their shock value. After reviewing numerous news articles over the weeks, students begin to have a negative outlook on their media sources. One student was quoted as saying, “Can we believe any of these studies?” (Plante and Reid 2011).

As identified earlier, social classes and ethnicities may be treated unfairly if the project is not set-up correctly. Without the use of proper guiding questions, students' discussions and interpretations may be too dependent on their prior experiences and cultural influences, leading to "the use of factually incorrect or contextually inappropriate experiences and influences." (Carvalho and Solomon 2012)

Despite the pitfalls that may be embedded in certain aspects of project-based activities or overly strict time constraints of the testing schedule, students can still take away much from these courses. For example, while students may report that data entry is too time consuming or difficult, their comments also suggest that these difficulties provide valuable insights into how the method of collecting data affects statistical analysis. Students noted that data entry allowed the class to see "a real-life dilemma" and that overall data entry provided "a good learning opportunity." (Wells 2006)

Chapter 3: Lesson Discussion

Aligning to the Exam

By the end of this unit, the student will have reviewed roughly 50% of what is covered on the AP Statistics exam. The College Board website has the following topics and the percentage each topic is covered on the test. I have included the topics that the worksheets and project will cover.

- Sampling and Experimentation: Planning and conducting a study (10%–15%)

Data must be collected according to a well-developed plan if valid information on a conjecture is to be obtained. This plan includes clarifying the question and deciding upon a method of data collection and analysis.

  - Overview of methods of data collection
    - Census
    - Sample survey
    - Experiment
    - Observational study
  - Planning and conducting surveys
    - Characteristics of a well-designed and well-conducted survey
    - Populations, samples and random selection
    - Sources of bias in sampling and surveys
    - Sampling methods, including simple random sampling, stratified random sampling and cluster sampling
  - Planning and conducting experiments
    - Characteristics of a well-designed and well-conducted experiment
    - Treatments, control groups, experimental units, random assignments and replication
    - Sources of bias and confounding, including placebo effect and blinding
    - Completely randomized design
  - Generalizability of results and types of conclusions that can be drawn from observational studies, experiments and surveys
- Anticipating Patterns: Exploring random phenomena using probability and simulation (20%–30%)

Probability is the tool used for anticipating what the distribution of data should look like under a given model.

  - Probability
    - Interpreting probability, including long-run relative frequency interpretation

        - Addition rule, multiplication rule, conditional probability and independence
    - The normal distribution
        - Properties of the normal distribution
        - Using tables of the normal distribution
        - The normal distribution as a model for measurements
    - Sampling distributions
        - Sampling distribution of a sample proportion
        - Sampling distribution of a sample mean
        - Central Limit Theorem
        - Sampling distribution of a difference between two independent sample proportions
        - Chi-square distribution
- Statistical Inference: Estimating population parameters and testing hypotheses (30%–40%)

Statistical inference guides the selection of appropriate models.

    - Estimation (point estimators and confidence intervals)
        - Estimating population parameters and margins of error
        - Logic of confidence intervals, meaning of confidence level and confidence intervals, and properties of confidence intervals
        - Large sample confidence interval for a proportion
        - Large sample confidence interval for a difference between two proportions
    - Tests of significance
        - Logic of significance testing, null and alternative hypotheses; p-values; one- and two-sided tests;
        - Large sample test for a proportion
        - Large sample test for a difference between two proportions
        - Chi-square test for goodness of fit, homogeneity of proportions, and independence (one- and two-way tables)

There are 3 worksheets created involving peer-reviewed articles over relevant issues to students, such as driving safety and drug usage amongst students. Each worksheet has excerpts from a single article that has only been modified for length, not vocabulary or syntax. Exposing students to professional works gives them expectations of what they will need to do and can be engaging to the student if not too overwhelming, which is why I decided to omit sentences that were not relevant to what students are learning in the course.

The unit is designed with Block scheduling in mind and is meant to supplement categorical analysis as it is covered, with the project being completed by the students throughout. The topics covered throughout should involve categorical analysis, including 1- and 2-Sample Z Tests for Proportions, Confidence Intervals and X^2 tests for Goodness of Fit and Homogeneity/Independence. The focus of the unit is over categorical analysis of contingency tables from independent populations, which can be explored using 1 or 2 sample proportion tests and confidence intervals and/or the various X^2 tests. The project designed at the end of the unit focuses solely on categorical data analysis. Throughout the teaching of categorical analysis, frequent references to the students' projects should be made to engage student interest and get them thinking more critically since the methods relate to them.

Unit Discussion: Introduction

For the intro of the unit, the project should be announced and the handouts, "AP Statistics Project – Categorical Data" and "AP Statistics Survey Project Scoring Rubric" (Appendix D), should be given to the students. This can be done any time during the regular teaching of the categorical chapters but it is ideally done on the first day. The teacher should either inform students that they are to form groups of 2 or 3 or assign groups with whatever method deemed appropriate, i.e. needs-based, randomly. The first goal of the students is to brainstorm ideas within their teams. Before the first worksheet for this unit, the students should submit their typed proposal and been approved. Remind students of the different sampling methods and different experimental designs for help with their proposal and so inference can be made.

The worksheets are a mix of multiple choice and free response questions, as is the format of the AP exam. The multiple choice questions are not designed to make answering the question easier. They are in the format of the AP exam in which all possible “plausible” answers are given as choices and students must choose the best answer among several good, but flawed, answers. The worksheets are intended to be covered as a class, unless otherwise stated. Making the worksheets relevant to the students by referencing their project and relating the problems and calculations to what the students should be doing for their data can build engagement in the students.

Unit Discussion: Worksheet 1

The first worksheet, “Driver and Passenger Seatbelt Use Among U.S. High School Students” (Appendix A), covers sampling and experimentation, probability and statistical inference with confidence intervals. This is best given after covering confidence intervals in the categorical data chapters. The role of probability in this unit is downplayed for time and relevance. The first 3 questions cover experimentation and sampling design. A follow-up question to the sampling design can be to have a student identify what the multiple stages of the sampling method are.

Question 4, dealing with probability, is fairly straight-forward and is a reminder to the students that more information can be inferred from the table than what is shown, in this case, by taking the complement. Question 5 is meant as a set-up for Question 6. Question 5 can be done as a class and Question 6 can be done independently, checking for understanding. Questions 7 and 8, done as a class, are meant to be set-up for questions 9 and 10, done independently to check for understanding. The teacher may choose to go over 9 and 10 as a class after sufficient time has been given for students to complete it on their own. Question 11 is designed so students review calculating confidence intervals. No interpretation of the interval is necessary for this question because the remaining questions deal strictly with interpretation. Question 12 can be independently solved to check for understanding for Question 11. The remaining 3 questions should be discussed as a class. The last question should bring about discussion over questions 4 and 5 since question 4 deals with a "difference" in proportions and question 5 deals with an actual direction. Discuss what the appropriate alpha levels are for those 2 questions. This can also lead into a discussion about power since there are two alpha levels. Remind students that they will need to use confidence intervals in their interpretation of their data.

Between the first worksheet and the second worksheet, the students should complete their data collection. The second and third worksheets are designed as a review of categorical analysis as well as present students with ideas as to how to arrange their data and interpret. There most likely will not be much time between worksheets 2 and 3 since they are both given at the end of the unit, possibly back-to-back. A deadline for phase 3 of the project, interpreting the data, should be informed at the beginning of worksheet two and should be set after worksheet three. A day may be set aside after worksheet three for students to work in groups on their project. This day should be focused primarily on data organization and, based on the organization, the different tests that are appropriate. This last point is stressed in the last worksheet where the students see how a Goodness of Fit test for one organization of the data can be turned into a test for difference in proportions or Test for Independence if the data are rearranged. Once the students have analyzed their data, the written report and presentation should be due soon after, possibly simultaneously.

Unit Discussion: Worksheet 2

Worksheet Two (Appendix B), “Panel Conditioning: Choosing Your Words Carefully”, is best done after the first day of the X^2 distribution. It focuses on experimentation and sampling design, as well as probability and statistical inference using the X^2 Test for Independence. The first 7 questions are over sampling and experimentation design. The intent of the research done in the article was to find out if the act of exposing students to questions regarding drug use causes students to use drugs more often. There was some significance found in the paper supporting their hypothesis and this can lead to a discussion over ethics in statistics, relating to the appropriateness of their projects.

The first 3 questions are a review of the first worksheet, so students can work independently on those questions. Questions 4-7 may need some prepping as these relate to the second part of the study. Have students answer question 4 independently. Then, inform students that in order for the researchers to carry out their experiment, they needed to gather preliminary data in the form of the survey done in the first part of the study. This is done fairly often when data is not already present for comparison. For question 7, some potential problems come from the randomization process, which can make the generalization of results questionable.

Questions 8 – 12 deal with probability, with question 9, 11 and 12 dealing with Independence of the form $P(B|A) = P(B)$. Questions 8 – 12 should be worked together, with teacher guidance. For Question 12, there should be some discussion over what it means that the two responses are not independent. This could suggest that the researches are correct in thinking that some change has occurred between the years. Discussion can also be had over whether this could suggest that exposure to the drug module is responsible for this change.

Questions 13 – 16 are very typical X^2 related questions but can be done as a class. The same discussions regarding independence can be had that were done for question 12, emphasizing what the use of independence means. In this case, rejecting independence means we conclude an association between the two years. Answering “Yes” for a particular year is influenced by the answer of a different year.

For question 17, we get to the assumptions for the X^2 test, the focus being that the assumptions do not hold under inspection. The samples of data were obtained with some degree of randomization but the samples are not independent. Discussion should revolve around the use of the word independent for sample selection being different than for sample responses. The samples, in this case, are dependent because they have been matched. What one subject said in 2008 gets matched to 2009. Therefore, the conclusions in question 16 are not valid because we chose the incorrect test. The correct test is beyond the scope of this course. Some discussion may occur around what students are doing in their project and making care to choose the correct test. If students find that their samples are not independent, they may want to reconfigure their data so they can at least run a Goodness of Fit test. The remainder of the worksheet can be assigned as homework since it is a direct copy of questions 8 – 18, but with a different, still dependent, table from the article. Again, remind students that X^2 tests are necessary for their project.

Unit Discussion: Worksheet 3

The final worksheet (Appendix C), "Why Do People Drink?", is best given at the end of the categorical analysis chapter. It deals with surveys, X^2 Goodness of Fit, 2-Sample Z-Test for Proportions and the X^2 Test for Independence. Of the first four questions, only question 2 may need teacher led guidance but all four questions should be answered independently before coming together as a class. The goal of question 2 is to reinforce the differences between experimentation (using a treatment) and observation studies (no treatment).

Questions 5 and 6 deal with univariate tables and serves more as a reminder of what students can do with their table if they happen to have random variables involved. Questions 7 – 11 deal with the GOF test. Some discussion should be made about failing to reject the Null Hypothesis for this table. We do not accept that the amount of heavy drinkers is the same for each level of income. This table simply does not show evidence that the amount of heavy drinkers is different for the various levels of income. This is shown in the remainder of the worksheet in which the drinkers are separated by gender and we can see differences for this table. Questions 12 – 15 should be worked as a class. Question 16 should entail discussion over what rejecting the Null Hypothesis means versus failing to reject the Null Hypothesis. Question 15 should have discussion over why the two separate tests result in the same conclusion, as in which test is more appropriate and which test has more power. The remainder of the worksheet can be assigned for homework since it is a copy of questions 5-16. The teacher may want to remind students that, for their project, the students may want to examine their data as separate categories or collapse categories, if possible and compare results.

With worksheet 3 completed, the unit is completed and the students should have all relevant tools required to complete their project. If a day is set aside for phase 3, the next meeting should be for turning in their written report and giving their presentation. If frequent references to the students' projects were made throughout the worksheets and the categorical units about how the students can use the various methods for their data, this can build student engagement and critical thinking. Student understanding can be observed through their interpretation during the presentation, answering students' questions and by reading their report and grading it according to the rubric. A more formal test can be created, if desired, using the data obtained from the students' projects and turning them into AP style questions, both multiple choice and free response.

If a day is taken for students to work on their data analysis so students may work in class with their partners, the teacher should facilitate discussion within groups rather than provide answers. The goal of the project is for student-centered learning. The teacher may find that directing the student to the appropriate worksheet is helpful. If a student happens to have samples that are dependent on each other, have them look carefully over Worksheet Two, for instance. Expectations should be made clear to students what is expected during their presentations, such as visual aids, knowledge of their material and adequate explanation of their findings. The teacher may find that emphasizing the rubric is helpful in aiding the student to narrow his or her focus for the presentation.

Unit Discussion: The Project

The project should be student-driven, starting with Phase I: Brainstorming. The teacher may want to provide students with some examples of what studies where the data type is categorical. Some examples are taste-tests of different products, opinion surveys of males versus females or comparing distributions of local wildlife to national wildlife. Students should work in their teams to decide what they find interesting that is also worth exploring.

The role of the teacher for the brainstorming process should not be limited to "idea generator". The teacher should help students narrow the scope of their ideas in such a way that data collection is possible within the students' limited means and time. Exploring the local wildlife, while an interesting idea, may not be suitable for a high school student taking seven other AP classes and extra-curricular activities. The teacher can help the teams focus more on the area around them. Instead of going as far as counting local wildlife, students could look at the distributions of local fauna or domesticated pets within their neighborhood. The teacher should also make sure the data gathered by the students can be analyzed based on the inferential procedures in the unit. A major component of these procedures is that the data be both random and independent. Worksheet two explores the problems when the data is correlated or the samples are dependent, namely that our inferential procedures are not appropriate.

Phases II and III are done at the students' leisure and discretion. However, throughout the unit, the teacher will want to stress the due dates for each of these. The Proposal must be done and approved before the data collection can begin so that students do not waste their time working for something that will not be interpretable or is not relevant or rigorous enough. Despite the fact that the students are at an AP level and the class is for college credit, the students are still teenagers that need guidance and focus. Daily reminders of due dates will be helpful to the students but still leaves everything up to them. Ultimately, the data should be obtained and organized by the time the unit is completed.

Phase IV: Get It Together can be done as a class if a day is taken at the end of the unit to do so. This will help the teacher ensure that students obtain the rigor desired in their interpretations and reinforce the tests of inference studied throughout the unit. If teams are finished with their analyses, then these groups can work on their presentations. Before Phase IV, the teacher can also inform students who are done with their report that they can bring whatever tools necessary to work on their presentations, such as cardboard, poster board and markers. The teacher can request that a rough outline be handed in by these teams of what they will be doing and saying for extra credit so that these students are not sitting idle.

The presentation and written report can be turned in on the same day or on separate days. During presentations, all students should be attentive and not allowed to work on their own presentations or reports. The teacher may want to inform students that every data set may be included on their Unit Exam that the teacher makes. If the teacher decides to do this, then careful planning must be done to make sure no team gets an easier test than another. For example, if a team has done their inference correctly, then they already know the answer to a test question. The teacher may wish to alter the “prompt” of the question, only use the summary statistics or scramble the data so that students have a more difficult time distinguishing whose project was used for which question. As an alternative to this, the teacher may simply state that if all students are paying attention during the presentations, then they should all know how to solve each problem on a test. In this way, no preferential treatment is given.

Chapter 4: Discussion and Conclusion

Revisions and Modifications

The content of this unit can be modified to fit a continuous data unit for 1- or 2-sample Z or T tests. The teacher only needs to find a theme in which to focus the material and find relevant research articles. For the purposes of the AP Statistics course, as long as the research has a sample size larger than 30 units, students are taught that the t-distribution is an adequate fit. In practice, for sample sizes larger than 30, the distribution must also not be too skewed. In finding articles, special care should be made to construct problems in such a way that balance the rigor of the AP exam and the relevance to their projects. The project is student-driven and application to practice can result in greater understanding than worksheets alone. The purpose of the worksheets should be to show students the highest standards they can achieve in their project and the different ways the content of the course is applied to their project.

An advantage in modifying this for a continuous data project is that different graphical methods can also be utilized in comparing the distribution of the samples for continuous data, such as box-plots, stem-and-leaf plots and histograms. Univariate Data comprises about 20% of the AP exam. The biggest limitation is students can only compare 2 samples, unless the project is given at the end of the year and the teacher has covered ANOVA tests. However, since the F-test is not on the AP Exam, many teachers feel ANOVA is beyond the scope of this course. Another limitation I have found in experience is finding research articles that provide the raw data if the data is continuous.

To work around this, a teacher can use software to generate random normal numbers if the research provides the mean and sample standard deviation. This method only works if the researchers proved the data to be approximately normally distributed. If the data happens to be skewed such that a different distribution was used, such as Poisson or Log Normal, the random numbers generated using the sample mean and variance could generate numbers that don't really make sense, such as test scores over a 100 or lengths that are negative. With this limitation in mind, finding appropriate and relevant research articles for AP students can be difficult but not impossible.

Conclusion

Statistics, as a mathematical concept, is still in its infancy, especially when it comes to the high school setting. Formal research in applied statistical projects for a high school classroom is limited and not easy to find. The majority of the research found in this report was for projects done in a college classroom. More research is needed for project based learning for grade school but since AP Statistics is taught for college credit, the college-based research and its success is somewhat appropriate.

The purpose of this report is to give AP Statistics teachers a foundation in applied statistics on upon which they can build. Teachers undergo AP training every few years to get a better understanding of the topics, share new, engaging activities and discuss successes and failures in previous activities. While these activities are fun and a nice way to introduce students to the content and formulas, I typically have not found these activities to be rigorous or relevant to the students.

Furthermore, in terms of AP Statistics training, unit long projects are not discussed and I feel that they should be. The purpose of this report is to give teachers a starting point for a unit long project but give them the freedom to teach the unit how they deem best. The worksheets provided are supplemental and only seek to add to the relevance of categorical data, why students are learning the inferential procedures in the unit, why the assumptions for these procedures are important and how these tests are actually carried out. However, the project and worksheets herein are in no way the exact route to take. I believe this work will take the form of a living document in which teachers will add and subtract details as they feel necessary. I have provided some ideas as to modifying the project already. The hope is that teachers will share their revisions, successes and failures with others. Informal research and data will prove useful in perfecting the teaching craft and helping our students to grow and understand statistics, as well as other topics.

Chapter 5: Application to Practice

Developing Engineering Awareness

I believe I have a much better understanding of engineering practices than when I started the program. I did not realize how much teamwork was emphasized. When we did the race car in the first summer, I was very worried that I would not be able to design a car by myself that would actually run. However, my partner and I came up with a solid idea after a lot of brainstorming that was very different from the other cars. I am not too sure how I can incorporate the idea of engineering careers into my lessons, as that was not extensively covered in this program, but I will definitely emphasize teamwork in the projects I develop.

The best way I can encourage teamwork in my classroom is to emphasize project-based learning. This program has helped me value more student-driven learning through projects. Most of the concepts we learned in the program was done through projects and teamwork. The highlights of these projects were the presentations. Presentations give the class a chance to view learning through the eyes of their peers as well as give the teacher a chance to assess student understanding. With my future projects I hope to incorporate into my classroom, I will make sure to highlight them with presentations.

Developing Engineering Habits of Mind

I feel that the UTeach Summer Master's program has allowed me to think of problem solving as a growing, living process rather than something that necessarily has a concrete beginning and end. I plan on incorporating this idea more in my AP Statistics classroom. Too often, students feel the need to reach an answer with finality to it rather than embrace the journey taken. This journey can be long, uncertain and painful and my students need to learn that failure is acceptable as long as they continue to try. They need to accept that they might choose an inappropriate statistical test to a problem and will simply need to erase and start over. I see students too afraid to attempt a word problem unless they are sure they will do it correctly. They would rather not try and fail rather than try, fail a few times and then maybe succeed.

The best way I can think of to force students to make attempts at problems they are unsure of is to have daily warm-ups of AP essay problems that have been slightly modified to ease students into the difficulty and rigor of the AP exam. I have done this in the past and have graded the work somewhat leniently to coax students into writing something down even if it is not completely correct. As the year progresses, students gain more confidence in their statistical knowledge and know-how and less scaffolding is necessary. I think I can improve on this by having students work together on difficult problems that have not been modified. Then, as a class, have a group share at least part of their solution and have a different group comment, critique or add to the solution. While this was not done in our UTeach program, we did do a lot of peer sharing of different parts of articles we read and then came together as a group to summarize the entire article. I am simply modifying this to meet my needs, such as engineers do.

Developing an Understanding of the Design Process

With my thesis, I changed it multiple times before I decided on what I finally have. I went too big in scope at first and realized quickly that I would not be able to ensure that students stayed aligned with important topics in the AP outline. This meant having to disregard a lot of research I read and completely changing the timeline of when to apply the project. I would not consider this time wasted. I learned a lot about what I wanted to do and found passion in what I finally created. I hope to instill in students that hard work can lead to great success. I also hope to teach them that hard work does not always look like success but is worth the risk. In practice, this comes in the form of more open-ended questions, more projects, more presentations and more time analyzing the process.

I believe this program has helped me to recognize the value of trying. Before I started the MASEE program, I had reservations that my math-oriented background would not be enough to get me through. Then, I attended the classes and realized that I had a lot to offer. I could also rely on working as a team to be successful. My students need to understand that we all can be important and useful. Again, I go back to the biggest hindrance in the classroom: students are afraid to make an attempt and fail. They need to recognize that there are so many opportunities for help. I hope to encourage more open-ended activities with my students where they have to collaborate. I believe my current project is designed so that 2 or 3 students working together can each contribute something meaningful and substantial to the final product. Having done a project similar to this with my students in the past, I can see the value students have in working hard and impressing their classmates with what they have done. Having done projects through the MASEE program that my team and I thought of on our own, I see the value in having students attain a sense of self-worth in the classroom that does not deal with a standardized test. While tests are important in our education system, informal assessments can be immediate and just as useful.

The project is very simple and easy to implement. I have constructed it in such a way that the unit be taught at the teacher's discretion while focusing on the relevance of the material to the students' projects. I feel that my work is not reflective of the UTeach*Engineering* process in that the unit is not necessarily taught from a student-based learning perspective. Teachers can give small activities to help students familiarize themselves with the topic, vocabulary and formulas but, in the end, the teacher decides what works best for his/her classroom. In my classroom, we have activities once or twice a week but other days are lecture based. The homework can be repetitive in the hopes of helping the students memorize the formulas and recognize the types of problems for which the formulas are appropriate.

Developing Knowledge for and of Engineering Teaching

As an AP Statistics teacher, I can incorporate a number of engineering-based studies that will be of interest to some of my students but not to all. While the goal of the teacher is to make everything engaging, I recognize my students have varied interests and need to allow them to use statistics to explore their values, beliefs, hobbies and tastes. I do not think I need to enforce the subject of engineering to develop an engineering state of mind. Statistics, at its foundation, is the basics of the design process: hypotheses, data collection, tests, interpretations, conclusions and revisions. Referencing the idea of engineering and relating their projects to the design process can help keep engineering in students' minds and help them see the value of what engineers do.

In this past year of teaching, I had students working in groups more often and give presentations more frequently. I did not restrict this to my AP Statistics classes. I tried these techniques in my remedial senior level math classes as well, with varying success. Some students were engaged and were able to find help in their peers while other students simply were not able to be reached. In terms of success and failure, I thought more students were more engaged while working in groups this year than in years past, which I consider a success. I feel this program has helped me to grow as a teacher and teach outside of my comfort zone. In the past, I felt like student-based learning involved me relinquishing my power and hoping that students take advantage. Now, I feel that student-based learning can be very teacher-guided and facilitated. With this project already completed, I have the confidence to make more unit-length projects, encourage more teamwork and take more time out from typical discussion for more student presentations.

Appendix A: Worksheet 1

Name: ____ **Date:_________________**

Worksheet 1: Driver and Passenger Seatbelt Use Among U.S. High School Students

"The national YRBS is a biennial self-administered survey of U.S. public and private high school students in grades 9–12. A stratified three-stage cluster sample design is used to obtain nationally representative samples of students. To provide sufficient statistical power for separate analyses of data among black and Hispanic students, the YRBS uses multiple strategies for oversampling by race and ethnicity." (Briggs 2008)

1. Based on the excerpt, what kind of study was conducted?
A. Experimental Study B. Observational Study

2. What primary method was used in the design of this study? Choose the best answer.
A. Simple Random Sample B. Stratified Random Sample C. Cluster Random Sample
D. Multi-stage Sampling E. Experiment with Blocking F. Experiment Completely Randomized

3. If we find that there is high correlation between ethnicity and seatbelt use, can we infer causation? Choose the best answer.
A. Yes, since this study is an experiment. B. No, because this is not an experiment.
C. Yes, since this study is an observational study. D. No, because this is not an observational study.
E. Yes, since high correlation is present.

The following are some summary statistics from the study.

	Driver	Passenger
Characteristic	%[a] (95% CI)	%[a] (95% CI)
TOTAL	59.0 (55.3, 62.6)	41.9 (38.8, 45.0)
Age (years)		
≥18	57.8 (52.8, 62.6)	43.0 (39.0, 47.0)
17	58.0 (54.1, 61.9)	41.8 (38.3, 45.3)
16	60.7 (56.9, 64.4)	41.4 (38.0, 44.8)
Gender		
Female	66.7 (62.7, 70.5)	46.0 (42.6, 49.3)
Male	52.1 (48.4, 55.8)	38.2 (35.2, 41.4)
Race/ethnicity		
White	60.6 (56.2, 64.8)	42.3 (38.8, 45.9)
Black	47.3 (42.9, 51.8)	36.9 (32.4, 41.6)
Hispanic	60.2 (54.9, 65.3)	43.8 (39.5, 48.1)
School grades		
Mostly A's	70.7 (65.9, 75.1)	50.2 (46.2, 54.2)
Mostly B's	61.4 (57.7, 65.1)	43.6 (40.4, 46.8)
Mostly C's[c]	44.4 (40.3, 48.7)	31.7 (28.4, 35.1)

4. What is the probability of a high school student over 18 not wearing a seatbelt while riding in the passenger seat?
a. 0.578 b. 0.430 c. 0.570 d. 0.422

5. Based on the confidence interval for a student riding in the passenger seat and makes mostly B's, is a different student more likely to wear a seatbelt riding in the passenger seat if that student makes mostly A's? Explain.
a. Yes, because the 95% confidence interval for "Passenger" and "Mostly B's" contains 43.6%
b. Yes, because the 95% confidence interval for "Passenger" and "Mostly B's" does not contain 50.2%
c. No, because the 95% confidence interval for "Passenger" and "Mostly B's" contains 43.6%
d. No, because the 95% confidence interval for "Passenger" and "Mostly B's" does not contain 50.2%

6. Based on the confidence interval for seatbelt use while being the driver, are Hispanics more likely to wear a seatbelt than Blacks? Why or why not?

7. What is the Margin of Error for the percent of drivers who wear seatbelts and are 16 years of age?

8. Based on the Margin of Error you found and the percentage given, how many high school students in the sample wear seatbelts while driving and are 16 years of age?

9. What is the Margin of Error for the total percent of passengers who wear seatbelts and are 18 years of age or older?

10. Based on the Margin of Error you found and the percentage given, how many high school students in the sample wear seatbelts while riding passenger and are 18 years of age or older?

11. There were about 560 females in the study. Show how the 95% confidence interval (62.7,70.5) was obtained for females saying "Yes" to wearing seatbelts while driving. (Note: It is OK to be off by about 0.1 due to their round-off error)

12. What is the probability of a female answering "No" to wearing a seatbelt while driving? Estimate this probability with a 95% confidence interval.

13. Do more females wear a seatbelt while driving than not? Explain using confidence intervals.

14. At the $\alpha = 0.05$ level, is there a difference in the proportions of males who wear seatbelts while driving compared to females? Explain.

15. At the $\alpha = 0.05$ level , can we use the confidence intervals provided in the summary table to test if the proportion of males who wear seatbelts while driving is lower than females? Why or why not?

Appendix B: Worksheet 2

Name: ___________________________________ **Date: __________**

Worksheet 2: Panel Conditioning: Choosing Your Words Carefully

The following is an excerpt from "Panel Conditioning in a Longitudinal Study of Adolescents' Substance Use: Evidence from an Experiment." (2012)

> "In October and November of 2008, adolescents were selected for a baseline survey … The primary sampling units were schools that contained a 7th grade. Schools were stratified by socioeconomic status (lower, middle and upper SES, as determined by the Chilean Ministry of Education) and a random sample was selected from within each stratum; low-SES schools were oversampled … The questionnaire included questions about their educational performance and expectations, relationship with parents, personality characteristics, social networks, family structure and socioeconomic characteristics. Most of the adolescents' questionnaires also included a "drug module" – a set of questions about adolescents' exposure to, perceptions of, and experiences with cigarettes, alcohol, marijuana and cocaine."

1. Based on the excerpt, what kind of study was conducted?
A. Experiment B. Survey C. Observational Study

2. What primary method was used in the design of this study? Choose the best answer.
A. Simple Random Sample B. Stratified Random Sample C. Cluster Random Sample
D. Convenience Sampling E. Experiment with Blocking F. Experiment Completely Randomized

3. If we find that there is high correlation between "relationship with parents" and "experiences with alcohol", can we infer causation? Choose the best answer.
A. Yes, since this study is an experiment. B. No, because this is not an experiment.
C. Yes, since this study is a survey. D. No, because this is not a survey.
E. Yes, since high correlation is present.

The ***2nd part of the study*** *continues as follows:*

> "In an effort to assess whether responses to questions on the drug module were subject to panel conditioning, we conducted the following experiment: some respondents were randomly allocated to the treatment condition – their questionnaire included the drug module – and the rest were assigned to a control group in which questionnaires did not include the drug module … In the initial 33 schools (2,163 students), all children were exposed to the drug module. In the subsequent 39 schools (2,836 students), 329 children were randomly assigned to the control condition (no exposure to the drug module) and the remaining 2,507 were assigned to the treatment condition (exposure to the drug module)"

4. Based on the excerpt, what kind of study was conducted?
A. Experiment B. Survey C. Observational Study

5. What primary method was used in the design of this study? Choose the best answer.
A. Simple Random Sample B. Stratified Random Sample C. Cluster Random Sample
D. Convenience Sampling E. Experiment with Blocking F. Experiment Completely Randomized

6. If the study shows that there is significant difference in answers between those that were exposed to the drug module and those that were not, can we infer causation? Explain.

7. Identify a potential problem that can be found in the design of the **2nd part of this study**. Explain.

Some of the results from the study are as follows:

Table 8: Pattern of Responses to Consumption Questions in 2008 and 2009 among Treated Respondents

	Alcohol 2009			
Alcohol 2008	No	Yes	Total	Percent
No	1,513	496	**2,009**	67.90
Yes	309	640	**949**	32.10
Total	**1,822**	**1,136**	**2,958**	100.00
Percent	61.60	38.40	**100.00**	

8. Based on the table, how many students said they had never tried alcohol in 2008?

9. What is the probability of a student in 2009 saying "Yes"?

10. What is the probability that a student changed his/her answer from 2008 to 2009?

11. What is P(Saying "Yes" in 2009|Saying "No" in 2008)?

12. Based on your answers above, is Saying "Yes" in 2009 **independent** of saying "No" in 2008?

13. Another way of testing for independence in a 2-way table is performing a X^2 Test for Independence. What is H_o for testing the table above for independence?

14. Create a table of the expected values, assuming H_o holds true. How many expected cell counts are greater than 5?

15. What is the X^2 test statistic? Show the appropriate amount of work.

16. Based only on your answers for the X^2 test, what conclusions can be made regarding independence for this table?

17. Were the two samples used in the survey obtained randomly and independent of each other? Keep in mind that the term "independent" is not used the same as in the previous questions.

18. Based on your answer to the previous question, does this change your conclusion for the X^2 test for Independence? Why or why not?

The following are more results from the study:

	Cigarettes 2009			
Cigarettes 2008	No	Yes	**Total**	Percent
No	1,807	364	**2,171**	73.40
Yes	206	581	**787**	26.60
Total	**2,013**	**945**	**2,958**	100.00

19. Based on the table, how many students said they had never smoked cigarettes in 2008?

20. What is the probability of a student in 2009 saying "Yes"?

21. What is the probability that a student changed his/her answer from 2008 to 2009?

22. What is P(Saying "Yes" in 2009|Saying "No" in 2008)?

23. Based on your answers above, is Saying "Yes" in 2009 **independent** of saying "No" in 2008?

24. Another way of testing for independence in a 2-way table is performing a X^2 Test for Independence. What is H_o for testing the table above for independence?

25. Create a table of expected cell values, assuming H_o holds true. How many expected cell counts are greater than 5?

26. What is the X^2 test statistic? Show the appropriate amount of work.

27. Based only on your answers for the X^2 test, what conclusions can be made regarding independence for this table?

28. Were the two samples used in the survey obtained randomly and independent of each other? Keep in mind that the term "independent" is not used the same as in the previous questions.

29. Based on your answer to the previous question, does this change your answer to the X^2 test for Independence? Why or why not? Explain.

Appendix C: Worksheet 3

Name: ___________________________________ **Date: __________**

Worksheet 3: Why Do People Drink?

The following is an excerpt from "Cognitive Predictors of Alcohol Involvement and Alcohol Consumption-Related Consequences in a Sample of Drunk-Driving Offenders. Substance Use & Misuse" (2008):

> "To better understand the pivotal role of cognition in drinking, the present study examines the prediction of high-risk drinking from a broad array of cognitive factors, using a sample of adults convicted of driving while impaired (DWI). DWI offenders represent a unique class of high-risk drinkers particularly because they often drink despite the severity of legal and financial sanctions imposed on them by society. In addition, some DWI offenders continue to drink unabated despite experiencing personal, social, and physical ramifications stemming from their excessive drinking practices. Evaluating the potential harmful effects from alcohol abuse, particularly for this group of high-risk drinkers, should entail considering a wide range of motivating factors that provides impetus for their continued drinking.
>
> Interviews were conducted from January 1994 to June 1997, and participants provided self-report information in response to survey questions and standardized tests and using a computerized version of the Diagnostic Interview Schedule (DIS) (Robins, Helzer, Croughan, and Ratcliff, 1981). Interviews were conducted by counselors having master's degrees and trained in intake assessment and referral processes (and lasted no more than 2 hours). Counselors rendered diagnoses of alcohol abuse or dependence based on extensive interview materials and written test results."

1. Based on the excerpt, what kind of study was conducted?
A. Experimental Study B. Observational Study

2. If this is an example of an experimental study, how could it be modified to be an observational study? If this is an example of an observational study, how could it be modified to be an experimental study?

3. What primary method was used in the design of this study? Choose the best answer.
A. Simple Random Sample B. Stratified Random Sample C. Cluster Random Sample
D. Convenience Sampling E. Experiment with Blocking F. Experiment Completely Randomized

4. If we find that there is high correlation between high-risk drinking and low income level, can we infer causation? Choose the best answer.
A. Yes, since this study is an experiment. B. No, because this is not an experiment.
C. Yes, since this study is an observational study. D. No, because this is not an observational study.
E. Yes, since high correlation is present.

Some of the results of the study are as follows:
(Univariate table, combining Male and Female, missing 31,200+ and Unknown)

Family Income	Total	%Total
<16,800	406	
16,800-31,199	377	33.3
31,200+	358	31.4

5. What percentage of those sampled had family income less than $16,800?

6. What is the probability of person from this sample having income of $16,800 or higher?

7. If the distribution of family income amongst high-risk drinkers were the same, what would be the probability of having income higher than $16,800?

8. What is the H_o for the X^2 Goodness of Fit test?

9. Show the expected cell counts next to the table, assuming H_o is true.

10. What is the X^2 test statistic? Show all relevant work.

11. What conclusions can you make about family income distribution amongst high risk drinkers?

Here are the same results, separated by gender.

Family Income	Females	%Females	Males	%Males
<16,800	264	41.7	143	28
16,800-31,199	191	30.3	186	36.5
31,200+	177	28	181	35.5

12. Which category has the smallest difference in proportion? What is the value of that difference?

13. What is the Null Hypothesis for testing whether there is a difference in proportions for this category?

14. What is the test statistic for this Null Hypothesis? Show all appropriate work.

15. What conclusions can you make about the table based on the value of the test statistic?

16. The conclusion you reached for the difference in proportions is the same conclusion if we tested the entire table using a X^2 Test for Independence. However, this is a different conclusion from the X^2 GOF we ran earlier. Why do you think this occurred? Explain.

Some more of the results of the study are as follows:

Ethnicity	Total	%Total
Non-Hispanic White	444	35.4
Hispanic/Mexican	590	47.1
American Indian	181	
Other	38	3.1

17. What percentage of those sampled have an ethnicity of American Indian or Other?

18. If the distribution of ethnicity amongst high-risk drinkers were the same, what would be the probability of having an ethnicity of American Indian or Other?

19. What is the H_o for the X^2 Goodness of Fit test?

20. Show the expected cell counts next to the table, assuming H_o is true.

21. What is the X^2 test statistic? Show all relevant work.

22. What conclusions can you make about the distribution of ethnicity amongst high risk drinkers?

Here are the same results, separated by gender.

Ethnicity	Females	%Females	Males	%Males
Non-Hispanic White	245	35	199	36
Hispanic/Mexican	336	47.9	254	46
American Indian	100	14.3	81	14.7
Other	20	2.8	18	3.3

23. Which category has the largest difference in proportion? What is the value of that difference?

24. What is the Null Hypothesis for testing whether there is a difference in proportions for this category?

25. What is the test statistic for this Null Hypothesis? Show all appropriate work.

26. What conclusions can you make about the table based on the value of the test statistic?

27. The conclusion you reached for the difference in proportions is the same conclusion if we tested the entire table using a X^2 Test for Independence. However, this is a different conclusion from the X^2 GOF we ran earlier. Why do you think this occurred? Explain.

Appendix D: Project Handouts

AP Statistics Project – Categorical Data

AP Statistics Survey Project Scoring Rubric

AP Statistics Project – Categorical Data

Phase I: Brainstorming

For this project, you will be in groups of 2 or 3. Your task is to design and execute an observational study, survey or experiment. You have complete freedom in your design of choice … just so long as it meets the following criteria:

- Appropriately rigorous for an AP/College-level course
- Is of interest to the school community (you may argue your case but I am both judge and jury)
- Involves categorical data
- Can be placed in a table in which the row and the column have 2 or more categories
- The row, the column, or both must have 3 or more categories.
- The sample/subjects/data is chosen in such a way that inference can be made (random, independent, etc)
- Interpretation of this data must involve (at minimum) each of the following
    - 2 confidence intervals
    - 1 sample proportion Z-Test
    - 1 difference in proportions Z-test
    - 1 X^2 Test for Independence/Homogeneity

Phase II: The Proposal (Due Date: ______)

Each team submits a typed proposal describing:

• Project type – observational study/survey or experiment

• General description of project idea

What question are you answering?

Why is this relevant?

• General description of project process and methodology

How will you gather the data? Sampling Method/Experimental Design Method

What is your randomization process?

Into what size table will the data fit? 3x2, 2x3, 3x4?

When, where, and how you will administer the project

********Note: Your proposal must be approved before you begin executing your project********

Phase III: Go Get That Data (Due Date: ______)

Execute your project in accordance with your proposal, making sure to use the randomization you specified

Phase IV: Get It Together

Organize, summarize, and analyze your data

Phase V: Write It Out (Due Date: ______)

Your written report will be graded based on the rubric provided, so read it carefully!!

Phase VI: Speak Your Mind (Due Date: ______)

A ten (10) minute opportunity for you to share the critical aspects of your project with your classmates. Make it interesting and read the rubric again!

AP Statistics Survey Project Scoring Rubric

Your work will be evaluated on a 0 to 4 scale on each dimension below.

4: Student meets every criterion listed in the category
3: One criterion is missing from the category
2: Two-Three criteria is missing from the category
1: Most criteria is not met
0: The category is missing

Topic/Question and Background (10%) ____*10 = ____

The project selected is clearly stated, is of interest to the school community, and is appropriately narrow in scope. The background provided gives strong motivation for the team's choice of this project and delineates its relevance to the school community. Also, the project is appropriately rigorous for an AP/College level course.

Methodology – Sampling/Survey Procedure or Experimental Design (15%) ____*15 = ____

The chosen sampling/survey procedure or experimental design is appropriate for addressing the selected topic/question, is described accurately, and is implemented according to the stated plan. The appropriate randomization process includes a clear and correct labeling of subjects, a description of the number selection process (random number table or calculator), and the results of that randomization (i.e. the numbers and subjects chosen).

Data Recording and Summarization (15%) ____*15 = ____

Original data provided and summarized in an appropriate neat and accurate tabular form. The student has correctly summarized the data using bar graphs/pie charts and counts/proportions/ percentages. Graphs and calculations are neat and accurate and well labeled.

Testing/Interpretation (25%) ____*25 = ____

The student thoroughly and accurately interprets the meaning of the graphical and numerical summaries in the context of the data, supported by appropriate inference tests and/or confidence intervals. In addition, the student identifies any generalizations that may be drawn about the population from which the sample was drawn.

Pitfalls and Extensions (10%) ____*10 = ____

The student articulates all pitfalls encountered, and clearly explains how (s)he dealt with each of these obstacles. In addition, the student shares at least one plausible extension of the survey project.

English Mechanics (10%) ____*10 = ____

The student's writing is grammatically correct, is punctuated properly, and flows logical from one point to the next. No spelling mistakes!!

Oral Presentation (15%) ____*15 = ____

The group accurately presents all key aspects of its survey project, including topic/question, background, methodology, data summary, graphical and numerical analysis, interpretation, and possible pitfalls/extensions. Correct terminology is used throughout and all members participate. The presentation is clear, well organized and fluent. Visual aids are used to assist the audience in understanding important points.

Total Points: ______ /400

Final Score: ______

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